

The following is a complete listing of all claims in the application, with an indication of the status of each:

Listing of claims:

1 1. (currently amended) A method of managing manufacturing logistics of end
2 products comprising the steps of:
3 maintaining an inventory of components, which components, termed
4 “building blocks”, are built to stock, each said component having a cost;
5 configuring-to-order end products using said components;
6 establishing a base-stock level for each of said components; and
7 replenishing said components from suppliers ~~following a base-stock~~
8 ~~policy that establishes a base-stock level for each of said components that~~
9 ~~minimizes in accordance with said base-stock levels so as to minimize a total~~
10 cost of inventory of said components,
11 wherein said cost of at least one component differs from said cost of at
12 least one other component.

1 2. (original) The method of managing manufacturing logistics of end
2 products recited in claim 1, wherein the end products are personal computers
3 (PCs) and the components are stock computer components.

1 3. (original) The method of managing manufacturing logistics of end
2 products recited in claim 1, wherein the base-stock levels are derived from a
3 greedy algorithm which iteratively reduces inventory budget until a budget
4 constraint is satisfied.

- 1 4. (currently amended) A computer implemented process of managing
2 manufacturing logistics of configure-to-order end products comprising the
3 steps of:
- 4 a) initializing a process of managing manufacturing logistics of
5 configure-to-order end products by setting $x_i := 0$ for each $i \in S$, setting $r_{mi} :=$
6 $P(X_{mi} > 0)$, setting $\beta_m := 0$ for each $m \in M$, and setting $\beta := 0$, where S is a set
7 of components indexed by i , M is a set of end products indexed by m , x_i is a
8 probability of no-stockout of a component of index i , r_{mi} is a probability that
9 a positive number of units of component i is used in the assembly of an end
10 product indexed by m , β_m is a probability of stockout of an end product of
11 index m , and β is an upper limit on the stockout probability over all end
12 products;
- 13 b) setting a set of active components to $A := \{\}$;
- 14 c) considering each $i \in S$, followed by considering each end product m
15 that uses component i in its bill-of-material;
- 16 d) setting $\beta_m := \beta_m + r_{mi} \Delta$, for all m such that $i \in S_m$ where Δ is a unit
17 step size;
- 18 e) computing the a difference $\delta_i := \max_m \{\beta_m\} - \beta$;
- 19 f) determining if $\delta_i \leq 0$, and if so, then adding component index i to the
20 set of active components, $A := A + \{i\}$;
- 21 g) determining if the set of active components is non-empty, and if so,
22 then setting $B := A$, otherwise setting $B := S$ where B is a set of component
23 indexes;

24 h) finding $i^* := \arg \max_{i \in B} \{-c_i \sigma_i / r_{mi} g'(x_i + \Delta/2)\}$, where $-g'(\bullet)$ follows
 25 the equation $-g'(x) = -\Phi(\bar{\Phi}^{-1}(x)) \cdot \frac{-1}{\phi(\bar{\Phi}^{-1}(x))} = \frac{1-x}{\phi(\bar{\Phi}^{-1}(x))}$, where $\Phi(\cdot)$ is a

26 probability distribution function of the standard normal variate, and $\phi(\cdot)$ is a
 27 probability density function of the standard normal variate;

28 i) setting $x_i^* := x_i^* + \Delta$ to update the probability of no-stockout of
 29 component i^* ;

30 j) computing $\beta := \max_{m \in M} \beta_m$, and checking whether inequality

31 $\sum_{i \in S} c_i \sigma_i g(x_i) \leq B$, where B is the budget limit on the expected overall

32 inventory cost, is satisfied and if so, stop and replenish components identified
 33 by said set B from suppliers following a base-stock policy that minimizes a
 34 total cost of inventory of said components i ,

35 wherein said cost c_i of at least one component differs from said cost
 36 c_i of at least one other component ;

37 k) otherwise, updating β_m and for each $m \in M_{i^*}$, set $\beta_m := \beta_m + r_{mi} \Delta$, and
 38 going to step b).

1 5. (currently amended) A system for managing manufacturing logistics of
 2 end products comprising:

3 means for maintaining an inventory of components, which
 4 components, termed "building blocks", are built to stock, each said component
 5 having a cost;

6 means for configuring-to-order end products using said components;

7 means for establishing a base-stock level for each of said components;
8 and
9 means for replenishing said components from suppliers ~~following a~~
10 ~~base-stock policy that establishes a base-stock level for each of said~~
11 ~~components that minimizes in accordance with said base-stock levels so as to~~
12 minimize a total cost of inventory of said components,
13 wherein said cost of at least one component differs from said cost of at
14 least one other component.

1 6. (original) The system for managing manufacturing logistics of end
2 products recited in claim 5, wherein the end products are personal computers
3 (PCs) and the components are stock computer components.

1 7. (original) The system for managing manufacturing logistics of end
2 products recited in claim 5, wherein the base-stock levels are derived from a
3 greedy algorithm which is iteratively computed by a processing unit to reduce
4 inventory budget until a budget constraint is satisfied.

1 8. (currently amended) A method that translates end-product demand forecast
2 in an assemble-to-order (ATO) environment into a forecast for components,
3 taking into account outbound leadtime comprising the steps of:
4 defining in an assemble-to-order (ATO) environment an end product
5 demand $D_m(t)$ of type m in period t , each unit of type m demand requiring a
6 subset of components, denoted $S_m \subseteq S$, as

$$D_i(t) = \sum_{m \in M_i} D_m(t + L_m^{\text{out}}); \text{ [and]}$$

8 deriving mean and variance for component demand $D_i(t)$ as

$$9 \quad E[D_i(t)] = \sum_{m \in M_i} \sum_{\ell} E[D_m(t + \ell)] P[L_m^{\text{out}} = \ell], \text{ and}$$

$$10 \quad \text{Var}[D_i(t)] = \sum_{m \in M_i} \sum_{\ell} E[D_m^2(t + \ell)] P[L_m^{\text{out}} = \ell] - \sum_{m \in M_i} \left(\sum_{\ell} E[D_m(t + \ell)] P[L_m^{\text{out}} = \ell] \right)^2, \text{ respectively; and}$$

11 replenishing said components from suppliers following a base stock
 12 policy that minimizes a total cost of inventory of said components, each said
 13 component having a cost,
 14 wherein said cost of at least one component differs from said cost of at
 15 least one other component.

1 9. (original) The method recited in claim 8, wherein the ATO environment is
 2 extended to a configure-to-order (CTO) environment for stationary demand,
 3 taking into account batch sizes comprising the steps of:

4 translating end-product demand into demand for each component i (per
 5 period) as

$$6 \quad D_i = \sum_{m \in M_i} \sum_{k=1}^{D_m} X_{mi}(k).$$

7 where $X_{mi}(k)$, for $k = 1, 2, \dots$, are independent, identically distributed (i.i.d.)
 8 copies of X_{mi} ;
 9 deriving marginal distributions, and then the mean and the variance of
 10 X_{mi} as

$$11 \quad E[D_i] = \sum_{m \in M_i} E[X_{mi}]E[D_m], \text{ and}$$

$$12 \quad \begin{aligned} \text{Var}[D_i] &= \sum_{m \in M_i} \left(E[D_m] \text{Var}[X_{mi}] + \text{Var}[D_m] E^2[X_{mi}] \right) \\ &= \sum_{m \in M_i} \left(E^2[X_{mi}] E[D_m^2] + \text{Var}[X_{mi}] E[D_m] - E^2[X_{mi}] E^2[D_m] \right), \text{ respectively.} \end{aligned}$$

1 10. (original) The method recited in claim 9, extended to non-stationary
 2 demand, wherein the mean and the variance of X_{mi} are generalized as

$$3 \quad E[D_i(t)] = \sum_{m \in M_i} E[X_{mi}] \sum_{\ell} E[D_m(t+\ell)] P[L_m^{\text{out}} = \ell], \text{ and}$$

$$4 \quad \begin{aligned} \text{Var}[D_i(t)] &= \sum_{m \in M_i} E^2(X_{mi}) \sum_{\ell} E[D_m^2(t+\ell)] P[L_m^{\text{out}} = \ell] \\ &\quad + \sum_{m \in M_i} \text{Var}(X_{mi}) \sum_{\ell} E[D_m(t+\ell)] P[L_m^{\text{out}} = \ell] \\ &\quad - \sum_{m \in M_i} E^2(X_{mi}) \left(\sum_{\ell} E[D_m(t+\ell)] P[L_m^{\text{out}} = \ell] \right)^2, \text{ respectively.} \end{aligned}$$

1 11. (currently amended) The method recited in claim 9, further comprising
 2 the steps of:
 3 defining $R_i(t)$ as a reorder point (or, base-stock level) in period t as

4
$$R_i(t) := \mu_i(t) + k_i(t)\sigma_i(t),$$

5 where $k_i(t)$ is the a desired safety factor, while $\mu_i(t)$ and $\sigma_i(t)$ can be derived
 6 (via queuing analysis) as

7
$$\mu_i(t) = \sum_{s=t}^{t+\ell_i^{\text{in}}-1} E[D_i(s)], \text{ and}$$

8
$$\sigma_i^2(t) = \sum_{s=t}^{t+\ell_i^{\text{in}}-1} \text{Var}[D_i(s)], \text{ respectively,}$$

9 where $\ell_i^{\text{in}} := E[L_i^{\text{in}}]$ is expected in-bound leadtime; and

10 translating $R_i(t)$ into “days of supply” (DOS), where the $\mu_i(t)$ part of
 11 $R_i(t)$ translates into periods of demand and the $k_i(t)\sigma_i(t)$ part of $R_i(t)$ is turned
 12 into

13
$$\frac{\frac{k_i(t)\sigma_i(t)}{\mu_i(t)}}{\ell_i^{\text{in}}}$$

14 periods of demand so that $R_i(t)$ is expressed in terms of periods of DOS as

15
$$\text{DOS}_i(t) = \ell_i^{\text{in}} \left[1 + k_i(t) \frac{\sigma_i(t)}{\mu_i(t)} \right].$$

1 12. (original) The method recited in claim 11, wherein demand is stationary
 2 in which for each demand class m , $D_m(t)$ is invariant in distribution over time,
 3 so that the mean and the variance of demand per period for each component i
 4 reduce to

5
$$\mu_i = \ell_i^{\text{in}} E[D_i], \text{ and } \sigma_i^2 = \ell_i^{\text{in}} \text{Var}[D_i], \text{ respectively, and}$$

6
$$R_i = \ell_i^{\text{in}} E[D_i] + k_i \sqrt{\ell_i^{\text{in}}} \text{sd}[D_i], \text{ and hence,}$$

7
$$\text{DOS}_i = \frac{R_i}{E[D_i]} = \ell_i^{\text{in}} + k_i \theta_i \sqrt{\ell_i^{\text{in}}} = \ell_i^{\text{in}} \left[1 + k_i \frac{\theta_i}{\sqrt{\ell_i^{\text{in}}}} \right],$$

8 where $\theta_i := \text{sd}[D_i]/E[D_i]$ is the coefficient of variation of the demand *per*
 9 *period* for component i , and hence $\theta_i / \sqrt{\ell_i^{\text{in}}}$ is the coefficient of variation of the
 10 demand over the leadtime ℓ_i^{in} .

13. (currently amended) A method that relates service requirements to base-stock levels of components in an assemble-to-order (ATO) environment comprising the steps of:

defining in an assemble-to-order (ATO) environment each order of type m as requiring exactly one unit of component $i \in S_m$, α as a required service level, referred to as off-shelf availability of all the components required to configure a unit of type m product, for any m , and E_i as an event that component i is out of stock;

determining a probability P for each end product $m \in M$,

$$P[\cup_{i \in S_m} E_i] \leq 1 - \alpha, \text{ and}$$

$$P[\cup_{i \in S_m} E_i] = \sum_i P(E_i) - \sum_{i < j} P(E_i \cap E_j) + \sum_{i < j < k} P(E_i \cap E_j \cap E_k) - \dots, \text{ and}$$

$$P[\cup_{i \in S_m} E_i] \cong \sum_{i \in S_m} P(E_i) = \sum_{i \in S_m} \bar{\Phi}(k_i) \leq 1 - \alpha; \text{ and}$$

establishing base stock levels for each component i that minimize a total cost of inventory of said components, each said component having a cost, wherein said cost of at least one component differs from said cost of at least one other component.

1 14. (previously presented) The method recited in 13, wherein the method is
 2 extended to a configure-to-order (CTO) environment taking into account batch
 3 sizes, further comprising the steps of:

4 defining $A \subseteq S_m$ as a certain configuration, which occurs in a demand
 5 stream with probability $P(A)$;

6 weighting a no-stockout probability, $\prod_{i \in A} \Phi(k_i)$, by $P(A)$;

7 changing the service requirement to

$$\begin{aligned}
 \alpha &\leq \sum_{A \subseteq S_m} P(A) \prod_{i \in A} \Phi(k_i) \\
 &\approx \sum_{A \subseteq S_m} P(A) [1 - \sum_{i \in A} \bar{\Phi}(k_i)] \\
 8 \quad &= 1 - \sum_{A \subseteq S_m} P(A) \sum_{i \in A} \bar{\Phi}(k_i) \\
 &= 1 - \sum_{i \in S_m} \left(\sum_{i \in A} P(A) \right) \bar{\Phi}(k_i); \text{ and}
 \end{aligned}$$

9 extending the CTO environment the service requirement to

$$10 \quad \sum_{i \in S_m} r_{mi} \bar{\Phi}(k_i) \leq 1 - \alpha$$

11 where r_{mi} is the probability that a positive number of units of component i is
 12 used in the assembly of an end product indexed by m .

1 15. (currently amended) A method that translates service requirements in
 2 terms of leadtimes into requirements for off-shelf availability of components
 3 comprising the steps of:

4 relating an off-shelf availability requirement to standard customer
 5 service requirements expressed in terms of leadtimes, W_m , where a required
 6 service level of type m demand is

$$7 \quad P[W_m \leq w_m] \geq \alpha, \quad m \in M,$$

8 where w_m 's are given data and P is probability;
 9 when there is no stockout at any store $i \in S_m$, denoting the associated
 10 probability as $\pi_{0m}(t)$, a delay being L_i^{out} , the out-bound leadtime;

11 when there is a stockout at one or several stores in the subset $s \subseteq S_m$,
 12 denoting the associated probability as $\pi_{sm}(t)$, so that the delay becomes
 13 $L_i^{\text{out}} + \tau_s$, where τ_s is the additional delay before the missing components in s
 14 become available;

$$15 \quad \text{determining } P[W_m \leq w_m] = \pi_{0m}(t)P[L_m^{\text{out}} \leq w_m] + \sum_{s \in S_m} \pi_{sm}(t)P[L_m^{\text{out}} + \tau_s \leq w_m];$$

16 assuming that

$$17 \quad L_m^{\text{out}} \leq w_m \quad \text{and} \quad L_m^{\text{out}} + \tau_s > w_m$$

18 both hold *almost surely*, so that when the (nominal) outbound leadtime is
 19 nearly deterministic and shorter than what customers require, whereas the
 20 replenish leadtime for any component is substantially longer; and

21 replenishing said components from suppliers following a base stock
 22 policy that minimizes a total cost of inventory of said components, each said
 23 component having a cost,

24 wherein said cost of at least one component differs from said cost of at
25 least one other component.